**Capstone: Secondary Process Evaluation**

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|  | **Methanol** | **Desalination** | **Hydrogen** |
| Operating Temperature | 740C | RO: Ambient | 530 |
| Operating Pressure | 70-100 bar | 55 - 85 bar | 1 bar |
| Method | Steam Reforming | RO   * cheaper * More energy eff * Needs high pressures * “Poorer” quality water | Cu-Cl Cycle |
| On site/offsite | On site | Either | On |
| Energy Usage |  | 4-6 kwh/m^3  ~.4$ per m^3 | - |
| Cost | $1.13/gallon | $4-12M/MGD | $2.02/kg |
| ROI |  | $1.1-$3/kgal (usually on lower side) | $1.00/kg approx. |
| Byproducts |  | Salty Brine (Environmental unfriendly)   * Salt crete * Sea salt * Road salt * Mineral separation | Final Byproducts are CuCl + Water  Both are reused |
| Efficiency | 78% |  | 41% |
| Production Rate | 12300 MMBtu/day | Order of 1 million gallons per day at full capacity | 2 kg/s |
| Licensing | Many Licensing processes exist |  | NGNP progress (NRC, DOE, NGNP Alliance) |
| Flexibility |  | Can be turned off and on at will be efficiency tanks if not consistently in use (20-40% of full operating potential) |  |
| Technology Readiness Level | Commercially developed | Proven and widely used technology | Proven |
| Safety | Safe, however because of the high temperature and pressure of the chemical plant is may be hazardous with both facilities in a certain range. Proceed with caution | Safe and proper protocol exist to ensure that plant is safe throughout operation lifetime | Safe. Uses same pressure as the nuclear reactor system except for the compression system which is not connected directly to the reactor. |

**Decision**: We started off analyzing several different processes that could be coupled with thermal or electrical energy. Ultimately, we put a primary focus on desalination, methanol production, hydrogen production. While methanol production was attractive due to the product’s versatility, the molten salt temperature needed for the process far exceeds maximum operating temperature of the ThorCon can. Additionally, while higher temperatures could be achieved with MSRs, material lifespan is cut significantly at these elevated temperatures.

Desalination was researched due to its potential to turn on and off at a whim. Thermal energy or electricity could be used for desalination but due to the high temperature of our supercritical steam, thermal energy cannot be used. This reduces the option to reverse osmosis which uses a high pressure differential (55-85 bar) and electricity meaning that the plant does not have to be close to the NPP. The detriment of this technology however is that it produces an environmentally unfriendly salty brine that cannot be repurposed in a financially efficient manner. Additionally, while this process can be ramped up and down, its efficiency tanks with irregular usage.

We ultimately chose hydrogen production as our secondary process. It has an operating temperature of 550C which pairs well with our system. It produces no negative by-products and there is a lot of information about hydrogen production and hydrogen producing paired with a supercritical steam cycle (the cycle used by ThorCon). Additionally, this technology operates at low pressures (other than the storage), creates a product with a wide range of uses and a large market, and seems to be financially viable.